Rock Chips

Fall/Winter 2004

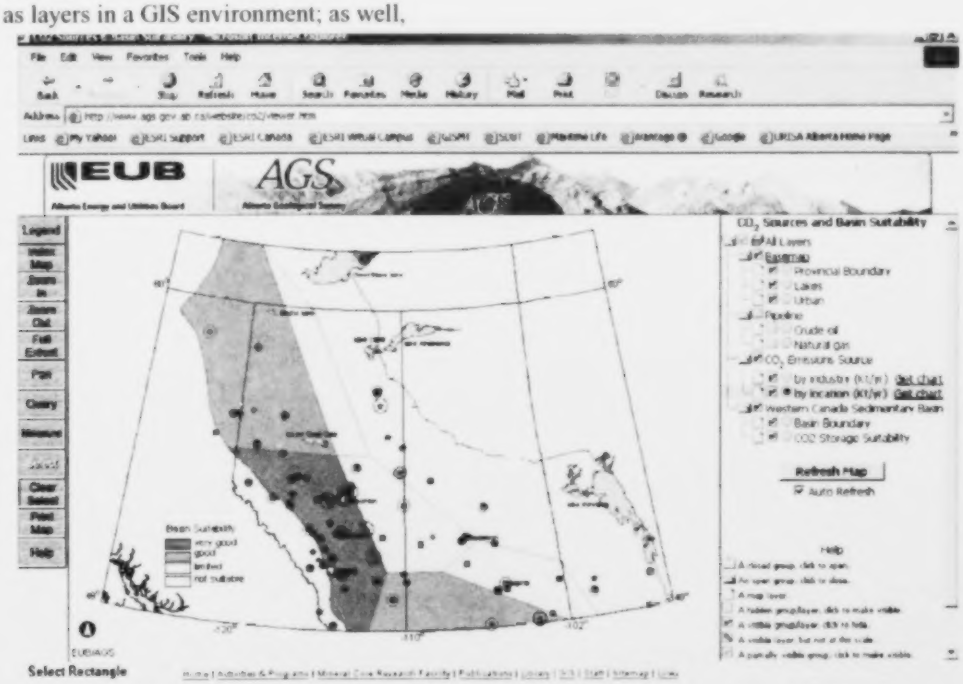
Alberta Geological Survey

Interactive Map of CO_2 Sources in the Western Canada Sedimentary Basin and Basin Suitability for CO_2 Storage

Identification of major CO_2 sources and their characterization is the first step in any and all programs for the reduction of CO_2 emissions into the atmosphere. Major stationary CO_2 sources (greater than 100 kilotonnes/year each) in the Western Canada Sedimentary Basin were inventoried in a 2001 study by the Canadian Energy and Research Institute (CERI) in which the AGS was a partner. AGS provided a basin-scale assessment of the suitability of the Western Canada Sedimentary Basin for geological sequestration of CO_2. Geographically, the most suitable area for CO_2 sequestration is in southwestern Alberta, which is also the location of most CO_2 emitters.

Data collected for the study were stored and managed as layers in a GIS environment; as well, an interactive web-based GIS map was created for disseminating these data to the public. The CO_2 Sources and Basin Suitability Internet Map Server (IMS) has nine map layers organized in four categories. These categories and their respective map layers are

1. Basemap - provincial boundaries, lakes and urban areas;
2. Pipeline - major pipelines transporting crude oil and natural gas;
3. CO_2 Emission Sources - emission level by different industries and by urban locations in kilotonnes per year;
4. Western Canada Sedimentary Basin – Basin boundary and CO_2 storage suitability classifications.



www.ags.gov.ab.ca/website/co2/viewer.htm

EUB Alberta Energy and Utilities Board

AGS

Layout Design and GIS Functionalities

The web page layout of the CO_2 Sources and Basin Suitability IMS (www.ags.gov.ab.ca/website/co2/viewer.htm) is divided into three parts – toolbar, map body and layer list. The toolbar contains buttons for map navigation and data manipulations. Map layers are displayed in the map body when they are switched on. The layer list is for managing display and/or activation of map layers by using the radio buttons and for toggling between layer listing and the legend.

When designing the functionality of the web page, our primary focus was on simplicity and ease of use. Users without any GIS or mapping training should be able to view data on the map, select data using queries and simple GIS functions, print customized maps and download selected data. These functionalities are grouped as map layer management, map navigation, map feature selections and database queries, and map printing.

Map Layer Management

Most of the map layer management is done in the 'layer list' area where users can switch on and off map layers individually or as a group, by category. They must also activate a map layer before performing feature selections or database queries on that layer. The layer list is replaced by map legends when the Legend button is switched on.

Map Navigation

Users can move around the map in the 'map body' using five navigation buttons - Index Map, Zoom In, Zoom Out, Full Extent and Pan. The Zoom In button magnifies an area of interest. Index map and Pan buttons are useful for panning to different areas after zooming in. The Zoom Out button deceases magnification gradually while the Full Extent button will return the map to Basin scale.

Map Feature Selections and Database Queries

All map layers can be queried by geographic area (Select button), or by attribute data (Query button). For example, users can 'select' all emission sources around Edmonton by drawing a box around Edmonton or they can 'query' emission sources levels that are greater than 500 kt/yr. Locations matching these criteria are

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highlighted on the map while their tabular data are displayed in a separate window. The 'Save attributes to text file' option will download these data as a comma delimited text file (.csv) to their computer. The Clear Select button will return data back to the database for other queries.

Query Selection Results - Microsoft Internet Explorer

Save attributes to text file

by location (Kt/yr)

Rec	Location	kTons/Year	Province	Longitude	Latitu
1	Boyle	1953	Alberta	-112.78	54.59
2	Windfall	494	Alberta	-116.217	54.2
3	Whitecourt	250	Alberta	-115.683	54.15
4	Kaybob	663	Alberta	-116.625	54.10
5	Redwater	973	Alberta	-113.121	53.98
6	Morinville	114	Alberta	-113.66	53.8
7	Ft. Sask. & Scotford	6178	Alberta	-113.083	53.76
8	Edson	225	Alberta	-116.433	53.58
9	Edmonton & areas	7498	Alberta	-113.484	53.53
10	Prentice	265	Alberta	-114.983	53.46
11	Genesee+Keephills+Wabamun+Sundance	26900	Alberta	-114.393	53.43
12	Hanlan	752	Alberta	-116.567	53.2

Table showing locations where emission levels are greater than 114 kilotonnes per year.

Map Printing

A hard-copy map can be produced using the Print button or the map may be saved as an image at any given time. When printing a map, users will be asked to enter a map title, select an image resolution and pick one of four printing formats – 8.5" x 11" portrait/landscape or 11" x 17" portrait/landscape. If map feature selections or database queries are on a map layer, the hard-copy map will include all selected records in a table and feature them highlighted on the map.

Two additional buttons are included in the 'toolbar.' The Measure button enables users to measure distance in kilometres between two points or to calculate the accumulated distance from a set of points. For example, users can determine the distance between CO_2 source locations and their closest pipeline or calculate the length of a pipeline. The Help button links to a page containing a brief description of all the buttons in the toolbar.

What's Next?

We are in the process of creating two more interactive web-based GIS maps on CO_2 Management. The Oil and Gas Pools IMS contains pool distributions in British Columbia, Alberta and Saskatchewan, and oil pools that are suitable for Enhanced Oil Recovery (EOR). The Basin Units IMS covers the aquifer characterizations (isopach, temperature and calculated in situ water density, etc) and CO_2 capacity calculations (maximum in situ CO_2 solubility, CO_2 capacity of saturated rock, etc.) of Viking and Keg River units. ❖

Story Contact Information

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Rock Chips is Increasing Publication Frequency	Maryanne Protz	(780) 427-2890
Surficial Mapping in the Bistcho Lake Area (NTS 84M)	Roger Paulen	(780) 427-2851
Groundwater Quality - An International Perspective	Tony Lemay	(780) 422-2619

They may also be contacted via e-mail by entering the author's first name.last name@gov.ab.ca

Rock Chips is Increasing Publication Frequency

Since 1990 (except 1993), the Alberta Geological Survey has produced the newsletter Rock Chips. As you can see below, it has gone through several changes over the years and it is about to make another. Currently the newsletter is published twice a year, spring/summer and fall/winter. As of 2005, Rock Chips will be published quarterly with editions in the spring, summer, fall and winter. We hope you continue to find the newsletter interesting and informative, and if you have any questions or comments, please contact our office.


ROCK CHIPS

New reservoir analysis initiative could turn resources into reserves

ALBERTA RESEARCH COUNCIL


Alberta Geological Survey

ROCK CHIPS

AGS finalizing geological atlas project

ALBERTA RESEARCH COUNCIL


ROCK CHIPS

Alberta Geological Survey celebrates 75th anniversary


ROCK CHIPS

AGS becomes part of the Alberta Energy and Utilities Board

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Rock Chips

Alberta Geological Survey

Implementation of a State-of-the-Art Monitoring System on Turtle Mountain

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A new addition to this section is reports for free download. These are selected reports and maps created within the last three years and saved as PDF files. Please note, many of these files are large (up to 80 MB) and can take a long time to download, depending on your connection speed.

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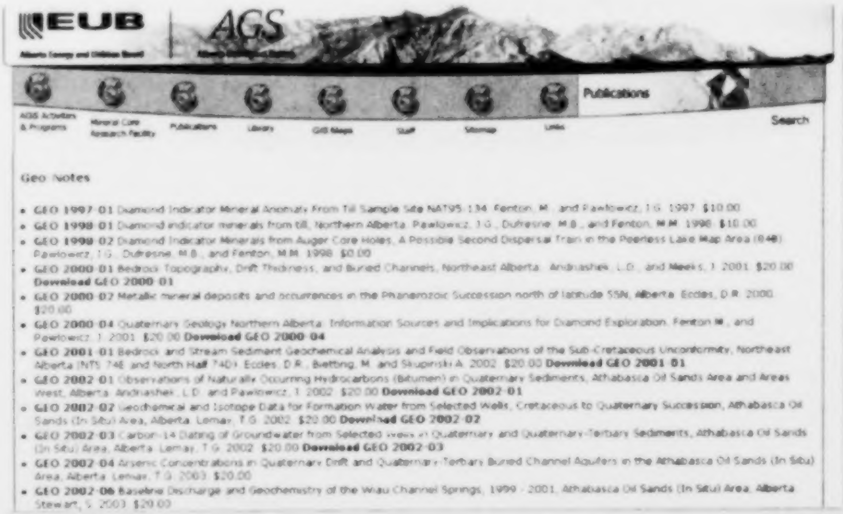

Surficial Mapping in the Bistcho Lake Area (NTS 84M)

During the summer of 2004, geologists from the Alberta Geological Survey (AGS) and the Geological Survey of Canada (GSC) were busy completing the surficial mapping of the Bistcho Lake (NTS 84M) region. This is the second year of a four-year collaborative, multi-disciplinary project that falls under the GSC's Northern Resource Development Program (NRD Project 4450) and has additional support through the Federal-Provincial Targeted Geoscience Initiative (TGI-2).

The Bistcho Lake region borders British Columbia to the west and the Northwest Territories to the north. There is a small hamlet at Zama City, which continues to grow around conventional oil and gas plays north of Hay Lake. Surficial geology mapping and studies of Quaternary stratigraphy were undertaken in support of future oil and gas development, mineral exploration, forestry and other land use development. This project will also be beneficial to the Dene Tha' in any land-use/ecological classification exercises they may undertake. Studies provided

- the identification of granular resources essential for the maintenance and development of road access and infrastructure;
- a reconstruction of glacial ice flow history, which is important to the successful application of drift prospecting;
- an assessment of the extent of permafrost that could impact future development.

Fieldwork was conducted during July, August and September 2004 and provided continuity with the surficial mapping conducted last summer in the Zama Lake (NTS 84L) map area, as well as surficial mapping being conducted as part of the same NRD project by the British Columbia Ministry of Energy and Mines and the GSC in the adjacent (west) Fontas River (NTS 94I) and Petitot River (NTS 94P) map areas. Upon completion of this project, a fully integrated, digital surficial geology database with seamless maps across the provincial border will be created.

Reconnaissance-level sampling of till and glaciofluvial sediments for kimberlite indicator minerals was completed. Samples were also collected to document the nature of the surficial deposits, preferably at locations where a vertical exposure provided a detailed examination of the weathering profile and subtle changes in sediment structure. Such sites also provide easy access to the C-horizon (parent material) (Figure 1). Till samples were collected for trace element geochemical analysis, carbonate content of the till matrix (silt+clay fraction) analysis, and grain size analysis. All analyses will be conducted in the coming year and results will be released in joint provincial-federal publications. During the course of surficial mapping, particular attention was paid to stratigraphy, ice-flow indicators, bedrock outcrops and the highly variable nature of the surface sediments. This information will help AGS decipher the glacial history of the region.

Figure 1. Sample site and mapping station within an old borrow pit on the southeastern flanks of the Cameron Hills Upland.

The Cameron Hills Uplands dominates the physiography of the region, and consists of Bistcho Plain, Cameron Hills, Elsa Hill and Bootis Hill. The Fort Nelson Lowland occurs along the southern margin of the map area. The uplands in the northern portion of the region are characterized by extensive peatlands, underlain by near-surface permafrost conditions. Fluted terrain occurs on the hills with arcuate recessional moraines draped over them (Figures 2 and 3). The lowlands to the southeast are characterized by flat topography and expansive fens developed over the glaciolacustrine sediments of glacial Lake Hay, which formed during deglaciation. In the southwest, the area is characterized by hummocky and ridged topography that is believed to reflect stagnation of ice and crevasse squeezing. Higher ground is densely forested with aspen and lodgepole pine, while intervening regions are predominantly bog and fen. Much of Bootis Hill and the low-lying region to the west is covered by ribbed moraine, representing greater than 100 terminus (retreating ice margin)

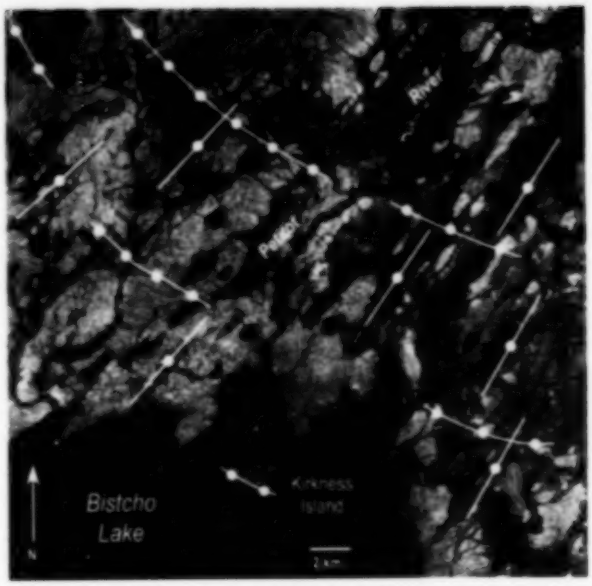

Figure 2. Landsat image, provided by PhotoSat, of a region north of Bistcho Lake. Flutings show a strong southwesterly ice-flow direction draped with recessional moraine ridges trending northwest-southeast.


Figure 4. A thin till veneer overlies an outcrop of Fort St. John Group shales exposed in a roadcut on the southeastern flank of the Cameron Hills Uplands.

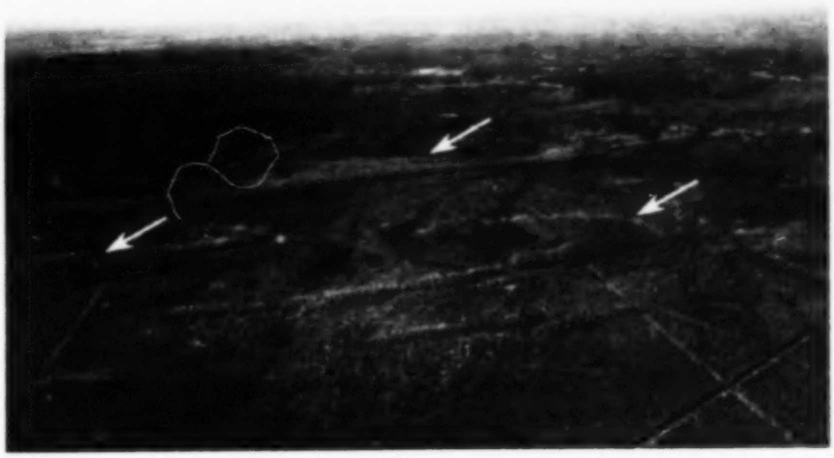
Figure 3. Series of recessional moraines (indicated by arrows) south of Bistcho Lake with expansive permafrost peatlands occurring between the ridges.

positions of a north-northwestly retreating ice lobe. Several bedrock outcrops were discovered in the region where previous bedrock topography and drift thickness maps had suggested thick (>250 m) glacial deposits. For example, poorly indurated shale of the upper Fort St. John Group (Shaftesbury Formation, Lower to Upper Cretaceous) crops out along the southern edge of the Cameron Hills Upland (Figure 4).

An extensive glaciofluvial meltwater complex occurs east of Bistcho Lake extending from the edge of the Cameron Hills to the edge of Bistcho Lake. Several meltwater channels have been incised into the till plain and large deposits of sand and gravel occur on terraces within the former meandering deglacial meltwater systems (Figure 5). Other notable glaciofluvial features include sand and gravel that were deposited at the margin of advancing glaciers and subsequently overridden by the Laurentide Ice Sheet. The hamlet of Zama City relies on two pits for aggregate where these ice-advance gravels are overlain by till (Figure 6). Smaller isolated kames and meltwater channels occur throughout the region. These are also potential sources of sand and gravel in a region that has otherwise limited aggregate potential.

Late Wisconsin ice flow history was reconstructed from streamlined landforms, striated boulder pavements and till pebble fabrics. These observations indicate that ice generally flowed across the region from the

Figure 5. An example of the glaciofluvial sand and gravel deposits that occur in the large meltwater complex east of Bistcho Lake. These deposits heavily influenced the placement and construction of the Paramount Resources Bistcho gas plant and airstrip.

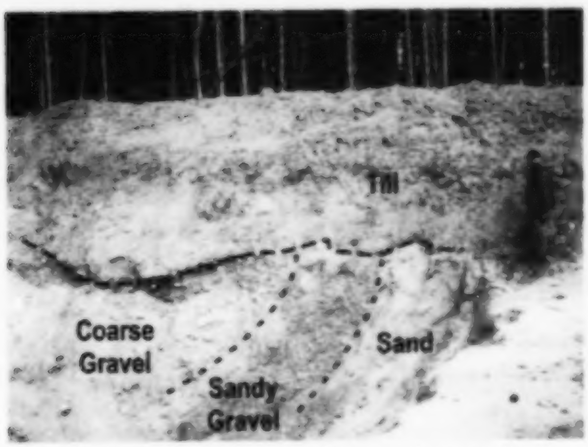

Figure 6. Sheared and rotated beds of a coarsening upwards ice-advance glaciofluvial deposit that was subsequently overridden by the Laurentide Ice Sheet. The clayey till at surface can mask the underlying aggregate deposit.

east-northeast to the west-southwest during the last glacial event. During deglaciation, thinning ice was strongly affected by topography. This is reflected by the pattern of ribbed moraine west of Bootis Hill; a till fabric from this area is interpreted to reflect a southeast flow direction, suggesting a distinct lobe of ice wrapped around the north side of the Cameron Hills and southwards past Bootis Hill. Flutings in the northeast portion of the map area indicate that ice

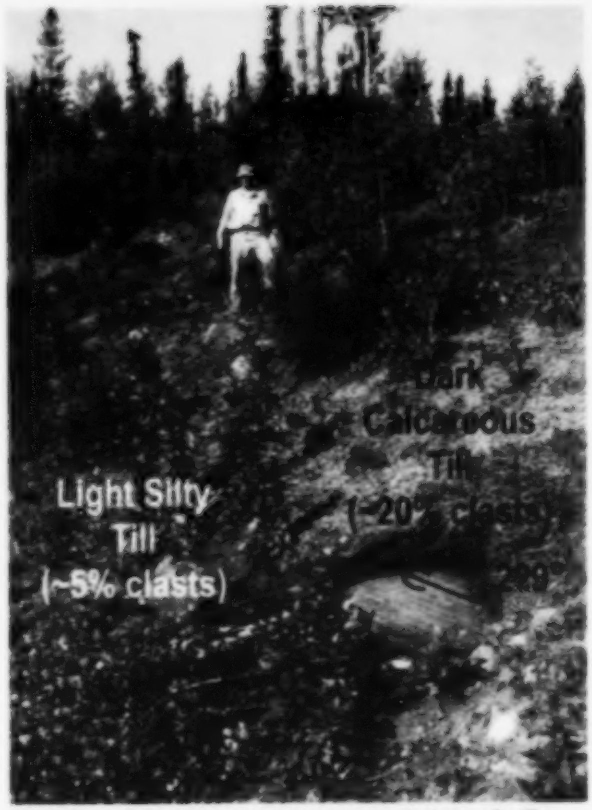

Figure 7. A polished clast pavement separates the lower silty till derived from the local shale bedrock of the Fort St. John Group and the upper calcareous sandy till derived from the Paleozoic limestones that crop out to the northeast. The polished limestone boulder in the foreground indicates ice flowed southwesterly, parallel to the flutings seen in Figure 2.

first flowed from the east and then from the northeast, which resulted in clayey regional till overlain by a stony carbonate-rich till (Figure 7).

Ice recession was rapid in the uplands, with recessional moraines spaced several kilometres apart. This contrasts with the area of ribbed moraine west of Bootis Hill, where moraines may only be tens to hundreds of metres apart. In the Fort Nelson Lowland to the south, retreating ice impounded the meltwaters and regional drainage, resulting in the formation of glacial Lake Hay. A thin veneer of glaciolacustrine sediments was deposited along the northern margins of the lake. Abundant iceberg scours and a thin deposit of diamicton, which is interpreted to be a till overlying contorted glacial lake sediments (Figure 8), indicate that ice re-advanced into the glacial lake basin during the latter stages of deglaciation. This was likely a brief local event within glacial Lake Hay prior to its drainage.

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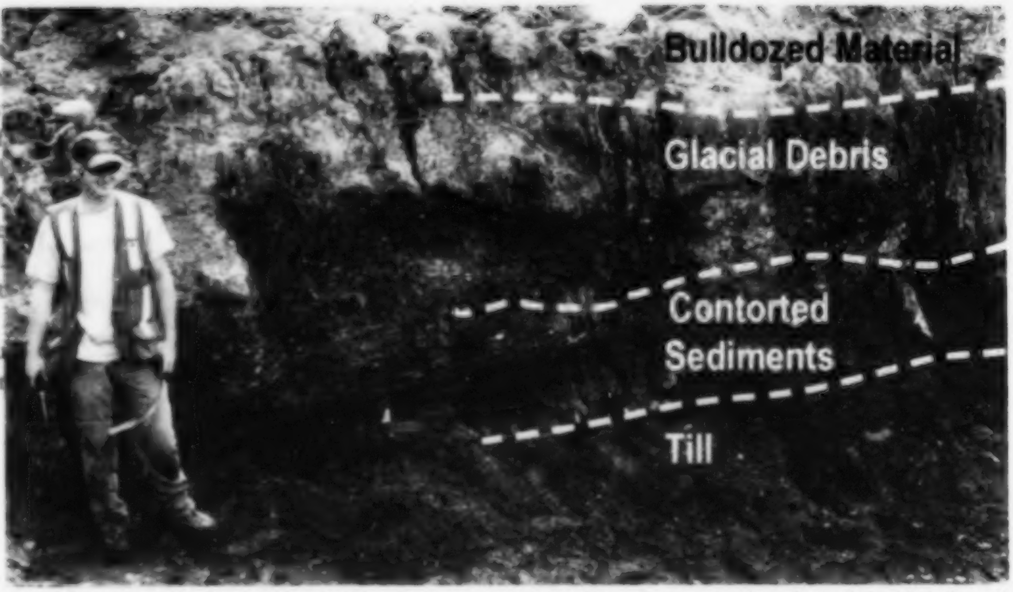

Figure 8. A thin veneer of glacial debris (diamicton) interpreted to be till overlies contorted, rhythmically bedded silts and clays, which in turn, overlies a thick deposit of till. This suggests that along the northern margin of Glacial Lake Hay, ice briefly readvanced back into the region prior to deglaciation.

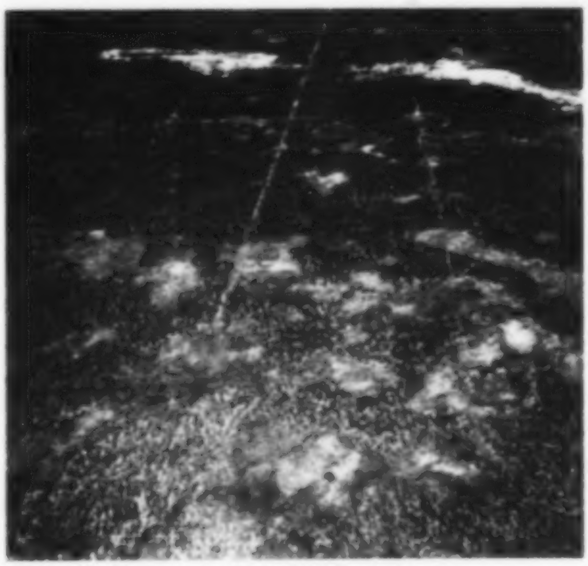

Figure 9. Black spruce peatland with thermokarst scars.

Figure 10. An older seismic line where the surface ground ice has melted down resulting in subsidence. Ice is melting laterally along the line boundaries, causing mature trees to bow and topple.

Groundwater Quality - An International Perspective

Since early in its history, the Alberta Geological Survey has been involved in assessing the chemical composition of groundwater throughout Alberta. Recently, the AGS has collected information on the chemical composition of groundwater from the Athabasca Oil Sands (in situ) Area (Figure 1), from coal, mixed coal-sandstone and sandstone aquifers throughout the Plains Region of Alberta (Figure 2), and in conjunction with Alberta Environment, from drift aquifers in the Cold Lake-Beaver River Basin (Figure 3). This last assessment was the focus of presentations made by the AGS at a recent International Association of Hydrogeologists (IAH) conference.

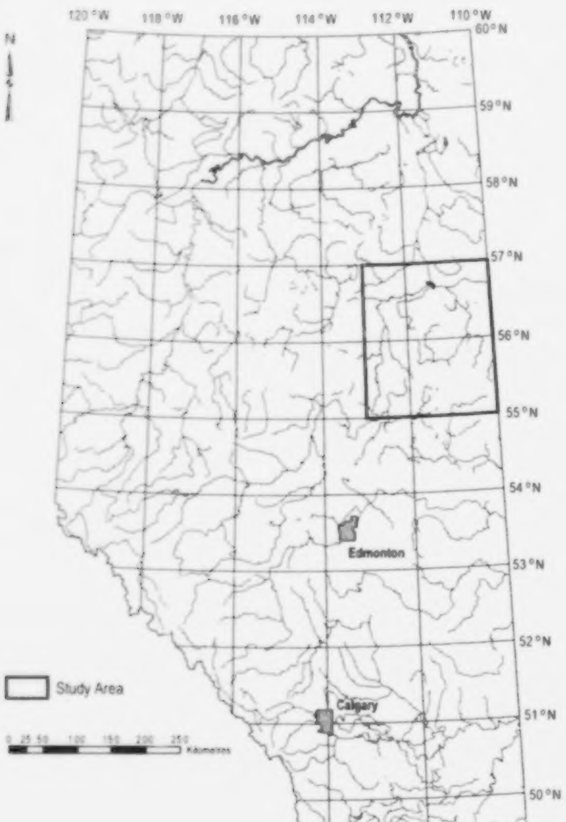

Figure 1. Athabasca Oil Sands (in situ) study area.

Figure 2. Plains coalbed methane (CBM) study area.

The IAH's Groundwater Quality 2004 - 4th International Conference was held between July 19 and 22, 2004, at the University of Waterloo in Waterloo, Ontario. The theme of the conference was **Bringing Groundwater Quality Research to the Watershed Scale**. The goal of the conference was to,

> "[*bring*] together renowned researchers from around the world [*to share their*] ground breaking research initiatives, innovative investigation and interpretive techniques, novel remediation approaches and recent breakthroughs in understanding the processes controlling groundwater quality"
> *Groundwater Quality 2004 conference website*

Researchers from over 30 countries submitted abstracts for papers or poster presentations (Figure 4), with more than 200 scientists attending.

Figure 3. Cold Lake - Beaver River Basin study area.

The AGS conference presentations were placed within the session on water quality surveys, policy and watershed management, and focused on the stratigraphy, chemical composition of groundwater, and the sensitivity and vulnerability to contamination of the drift succession within the Cold Lake-Beaver River Basin (Figure 3). The activities associated with this project included compilations of existing data, implementation of a database management system, integration of the data within a GIS, map generation, and report preparation. Similar approaches to assessing groundwater quality were presented for Ontario, the U.K. and Mexico.

While discussion of water quality surveys, policy and watersheds made up a significant portion of the conference agenda, the majority of the conference focused on contaminant behaviour in the subsurface, delineation of contaminated sites, remediation strategies, as well as monitoring to assess the effectiveness of the chosen remediation strategies. The presentations and posters demonstrated that many nations are working toward protecting their increasingly important groundwater resources. They highlighted the enviable position Canadians appear to be in regarding the quality of water resources compared to other countries. Because of unfortunate circumstances, such as late detection of contaminant plumes, many of the approaches used to deal with groundwater quality issues throughout the world are reactionary rather than being proactive. The examples cited underscored the importance of solid

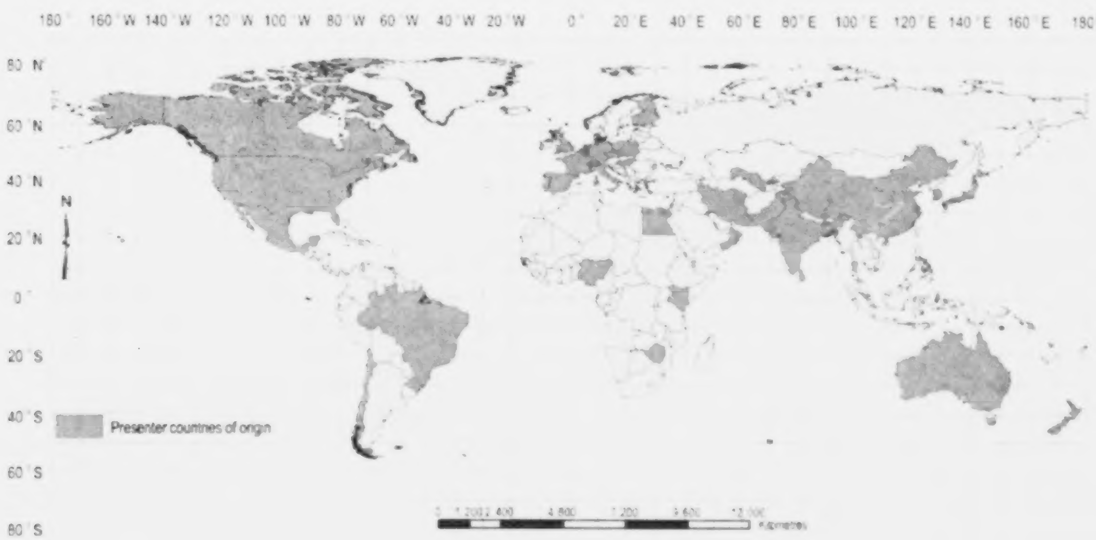

Figure 4. World map showing the presenter countries of origin.

decision-making processes and high quality baseline datasets in assessing site suitability for certain types of development, and of the need for careful design of monitoring networks to ensure that the risks associated with development can be minimized.

With these goals in mind, much of the current research occurring within the groundwater quality community is focusing on better ways of undertaking site characterization, designing monitoring well systems, developing and testing remediation technology, and implementing and monitoring natural attenuation schemes that take advantage of such processes as (bio)degradation, irreversible sorption, dilution, dispersion and/or decay of contaminants in soil and groundwater.

The knowledge gained from participating in such conferences is beneficial in a number of ways. Since current and future development in Alberta has the potential to affect groundwater quality, learning from the failures and, perhaps more importantly, from the successes of others with respect to protecting groundwater quality, provides examples of how to safeguard this resource. In addition, the exchange of ideas and comparison of methodologies fosters the development of scientific relationships and identifies new avenues of research or new approaches to current areas of research.

The theme of the conference was "Bringing Groundwater Quality Research to the Watershed Scale." The work undertaken by the AGS and Alberta Environment in the Cold Lake-Beaver River Basin is a good example of such groundwater quality work. ❖

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Digital Datasets

DIG 0076 Alberta Sand and Gravel Deposits with Aggregate Potential (GIS data, polygon features). 11.3 MB. $20.00

Geo-Notes

GEO 2004-01 Desorption and Adsorption of Coal in the Coal Valley Area, Alberta Foothills. 565 KB PDF. $20.00

Information Series

INF 127 Geoscape Calgary. Poster. $15.00

Mineral Assessment Reports

MIN 20030004 2001 and 2002 Exploration and Field Work on the Baseline Ridge Permit, West-Central Alberta. 22 p. and 1 map.

Special Reports

SPE 71 Preliminary Release of Geochemical, Mineralogical and Kimberlite Indicator Mineral Electron Microprobe Data from Silts, Heavy Mineral Concentrates and Waters from a National Geochemical Reconnaissance Stream Sediment and Water Survey in the Northern Buffalo Head Hills Area, Northern Alberta (Parts of NTS 84F, 84G and 84K). 3.56 MB PDF as well as data files. $20.00.

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Code	Title
Bulletins	
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BUL 013	Groundwater geology and hydrology of east-central Alberta
BUL 016	Geology and groundwater resources of the Peace River district, northwestern Alberta
BUL 017	Groundwater geology, movement, chemistry and resources near Olds, Alberta, Canada
BUL 019	Geometric coefficients for use in numerical resistivity analysis
BUL 024	A hydrogeological study of the Three Hills area, Alberta
BUL 030	Petrographic and engineering properties of fine-grained rocks of central Alberta
BUL 036	Multiple glaciations in the Foothills, Rocky Mountain House area, Alberta
Economic Geology Reports	
ECO 6	Silica sands in the Fort McMurray area, Alberta
Earth Sciences Reports	
ESR 00-15	Quaternary stratigraphy of the buried Birch and Willow bedrock channels, northeastern Alberta
ESR 56-02	Glacial geology of Castor district, Alberta
ESR 56-04	Stream-trench systems in east-central Alberta
ESR 57-02	Glacial geology, Alliance-Brownfield district, Alberta
ESR 58-01	A general outline of groundwater conditions in the Alberta plains region
ESR 58-02	Industrial minerals of Alberta
ESR 59-02	Groundwater geology, Beaverlodge district, Alberta
ESR 60-01	Evaluations of some Alberta coal deposits
ESR 61-03	A farm water supply from quicksand
ESR 62-04	Water well records, Peace River district, Alberta (complete to January, 1962)
ESR 62-05	Reconnaissance groundwater study, Swan Hills and adjacent areas, Alberta
ESR 64-01	Analysis of silicate rocks. Part I. Routine determination of major constituents
ESR 65-01	Bedrock topography of southwestern Alberta
ESR 65-03	Athabasca Oil Sands bibliography (1789-1964)
ESR 65-04	Water well records, southern Alberta, townships 1-10 (complete to December 31, 1964)
ESR 66-04	Water well records, Alberta townships 11-25 (complete to December 31, 1965)
ESR 69-01	Groundwater chemistry and hydrology of the Handhills Lake area, Alberta

ESR 74-05	Susceptibility of geologic deposits to erosion in the House Mountain area, Alberta
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ESR 76-06	Index to uranium assessment reports for quartz mineral exploration permits, northeastern Alberta
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INF 018	Preliminary report of geological field work, northeastern Alberta, June 30 - August 27, 1953
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OFR 73-22	Geological factors affecting land development at Fort McMurray, Alberta
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OFR 96-01C	Hydrogeology of the Cold Lake study area Alberta, Canada. Part 3. Hydrochemistry
OFR 96-01E	Hydrogeology of the Cold Lake study area Alberta, Canada. Part 5. Hydrometeorology
OFR 96-01H	Hydrogeology of the Cold Lake study area Alberta, Canada. Data base: Section 1 - Phanerozoic data
OFR 96-01I	Hydrogeology of the Cold Lake study area Alberta, Canada. Data base: Section 2 - Quaternary data
OFR 96-01J	Hydrogeology of the Cold Lake study area Alberta, Canada. Data base: Section 3 - Instrumentation for hydrogeological investigations
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REP 58	The components of the bitumen in Athabasca bituminous sand and their significance in the hot water separation process.
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American Association of Petroleum Geologists and (AAPG) 2005 Annual Convention
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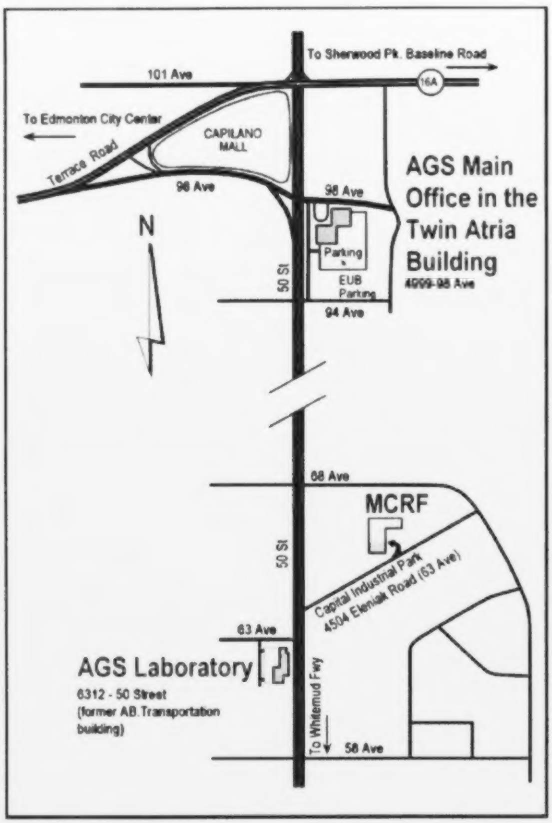

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